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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/994,395	11/26/2001	Sergey D. Lopatin	039153-0457 (G1162)	7882

7590 03/31/2008

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ART UNIT	**PAPER NUMBER**
2811	

MAIL DATE	DELIVERY MODE
03/31/2008	PAPER

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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application Number: 09/994,395
Filing Date: November 26, 2001
Appellant(s): LOPATIN ET AL.

Joseph N. Ziebert
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed January 3, 2008 appealing from the Office action mailed July 12, 2007.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection to be reviewed on appeal is correct.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

6399496	Edelstein et al.	6-2002
6749699	Bogel et al.	6-2004
6380083	Gross	4-2002
6440849	Merchant et al.	8-2002
6090710	Andricacos	7-2000

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

1. Claims 1-3, 6,10,15,17-20 and 22 are rejected under 35 U.S.C. 102(e) as being anticipated by Edelstein et al. as supported by Bogel et al.

Edelstein et al. teach in figures 2 and 4 and related text a method of fabricating an integrated circuit, the method comprising:

depositing an etch stop laver 101 over a first conductive laver 46, wherein the etch stop laver is in direct contact with the first conductive laver;

depositing an insulating laver 54 after the etch stop laver is deposited over the etch stop laver;

forming a barrier layer 72 extending along lateral side walls and a bottom of a via aperture, the via aperture being configured to receive a via material that electrically connects the first conductive layer 46 and a second conductive layer 56; and

depositing/filling a copper 76 alloy via material in the via aperture to form a via, the copper alloy material including Zinc (Zn) or Silver (Ag) and at least one element for increasing grain size including Calcium (Ca) or Chromium (Cr) (column 8, lines 35-52). Although figure 2 of Edelstein et al. does not depict the processing steps of making the device, figures 4A to 4D of Edelstein et al. and related text describe the processing steps of forming a double damascene structure.

Although Edelstein et al. do not explicitly state that said at least one element increases the grain size, the claimed limitation of “at least one element for increasing grain size including Calcium (Ca) or Chromium (Cr)” is inherent in Edelstein et al.’s device, because it is known in the art that the inclusion of Calcium (Ca) or Chromium (Cr) increases the grain size.

Bogel et al. is cited as supporting evidence that the inclusion of Calcium (Ca) or Chromium (Cr) increases the grain size (figures 3-4, column 7, line 65 to column 8, line 17).

Regarding claim 22, the claimed limitation of stuffed grain boundaries is inherent in Edelstein et al.’s device, because Edelstein et al.’s structure is identical to the claimed structure.

2. Claims 8, 13 and 16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Edelstein et al. in view of Bogel et al.

Edelstein et al. teach substantially the entire claimed structure, as applied to claims 1, 6 and 10-11 above, except Calcium (Ca) or Chromium (Cr) having one atomic percent or less.

Bogel et al. teach that Calcium (Ca) or Chromium (Cr) having one atomic percent or less (column 7, lines 65-67).

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to use Calcium (Ca) or Chromium (Cr) having one atomic percent or less in prior art's device in order to provide a stable Cu alloy with improved electromigration properties.

3. Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over Edelstein et al. and Bogel et al., as applied to claims 1 and 17 above, and further in view of Merchant et al.

Regarding claim 4, Edelstein et al. and Bogel et al. teach substantially the entire claimed structure, as applied to claim 1 above, except the copper alloy via material includes one atomic percent or less of Zinc (Zn) or Silver (Ag).

Merchant et al. teach the copper alloy via material includes one atomic percent or less of Zinc (Zn) or Silver (Ag) (column 3, lines 6-12).

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to use the copper alloy via material includes one atomic percent or

less of Zinc (Zn) or Silver (Ag) in prior art's device in order to provide a stable Cu alloy with improved electromigration properties.

4. Claims 9 and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Edelstein et al. and Bogel et al., as applied to claims 1, 6 and 17 above, and further in view of Gross.

Edelstein et al. and Bogel et al. teach substantially the entire claimed structure, as applied to claims 1, 6 and 17 above, except the increased grain size is between 0.5 and 3 microns.

Gross teaches an increased grain size is between 0.5 and 3 microns (column 5, lines 30-36).

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to use an increased grain size is between 0.5 and 3 microns in prior art's device in order to provide a stable Cu alloy with improved electromigration properties.

5. Claims 11-12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Edelstein et al. and Bogel et al., as applied to claim 10 above, and further in view of Andricacos et al. (6,090,710).

Edelstein et al. and Bogel et al. teach substantially the entire claimed structure, as applied to claim 10 above, except the ternary copper alloy via material is at least 98 atomic percent copper and includes Zinc (Zn), Silver (Ag), or Tin (Sn).

Andricacos et al. teach a ternary copper alloy via material is at least 98 atomic percent copper and includes Zinc (Zn), Silver (Ag), or Tin (Sn) (column 8, lines 15-16 and table 1).

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to use a ternary copper alloy via material is at least 98 atomic percent copper and includes Zinc (Zn), Silver (Ag), or Tin (Sn) in prior art's device in order to obtain low resistance copper alloy for vias.

(10) Response to Argument

1. Appellant argues on pages 7-10 that Edelstein et al. as supported by Bogel et al. do not teach the claimed limitation of *"at least one element for increasing grain size including Calcium (Ca) or Chromium (Cr)",* because *"Edelstein et al. does not mention grain size at all"* (page 7, last paragraph) and *"Bogel et al. does not provide the missing teaching either. It describes change in grain growth due to annealing time and temperature, not by the addition of an element"* (page 8, first paragraph).

Independent claim 1 recites *"A method of fabricating an integrated circuit, the method comprising: ….. copper alloy material including Zinc (Zn) or Silver (Ag) and at least one element for increasing grain size including Calcium (Ca) or Chromium (Cr)".* Independent claims 10 and 17 recite similar limitations *"ternary copper alloy via material includes an element with a characteristic for increasing grain size of the ternary copper alloy via".* Edelstein et al.

explicitly teach the method of fabricating an integrated circuit, as recited in claim 1, including a copper alloy material including Zinc (Zn) or Silver (Ag) and at least one element including Calcium (Ca) or Chromium (Cr). Appellant does not argue that Edelstein et al. teach said claimed limitations. Appellant only argues that Edelstein et al. do not teach *"at least one element for increasing grain size including Calcium (Ca) or Chromium (Cr)"*. In other words, appellant argues that although Edelstein et al. teach the method of forming a device comprising a copper alloy material including Zinc (Zn) or Silver (Ag) and at least one element including Calcium (Ca) or Chromium (Cr), said one element is not used "for increasing grain size".

The claimed limitation of *"at least one element for increasing grain size including Calcium (Ca) or Chromium (Cr)",* recites <u>the intended use</u> of the "at least one element". An artisan fabricating the claimed integrated circuit, as taught by Edelstein et al. as supported by Bogel et al., will obtain a structure identical to the claimed structure. The structure obtained can certainly be used "for increasing grain size", because it comprises the at least one element including Calcium (Ca) or Chromium (Cr). Note further that a recitation of an intended use of the claimed invention must result in a structural difference between the claimed invention and the prior art in order to patentably distinguish the claimed invention from the prior art. If the prior art structure is capable of performing the intended use, then it meets the claim.

Furthermore, the claimed limitation of *"for increasing grain size",* does not necessarily call for a structure whose grain size has been increased. The broad interpretation of *"for increasing grain size"* means a structure comprising an element

capable of increasing the grain size. Since the structure of Edelstein et al. as supported by Bogel et al. comprises the same element, then it is capable of increasing the grain size, and thus meets the claimed limitation.

Moreover, the claimed limitation of forming a structure comprising a *"copper alloy material including Zinc (Zn) or Silver (Ag) and at least one element for increasing grain size including Calcium (Ca) or Chromium (Cr)"* simply means that the inclusion of Calcium (Ca) or Chromium (Cr) in a copper alloy material comprising Zinc (Zn) or Silver (Ag) will increase the grain size. Edelstein et al. teach a copper alloy material including Zinc (Zn) or Silver (Ag) and at least one element including Calcium (Ca) or Chromium (Cr). Therefore, Edelstein et al.'s structure inherently includes the claimed limitation of *"at least one element for increasing grain size",* as claimed.

Please note further that the claimed limitation of *"for increasing grain size",* as recited in claim 1, and *"for increasing grain size of the ternary copper alloy via",* as recited in claims 10 and 17, does not specify as to which grain appellant refers (with respect to claim 1) and does not specify from which size the grain should increase. Clearly, Edelstein et al.'s structure comprises a "grain size" which can be increased from an arbitrarily smaller size grain.

2. Appellant argues on pages 8 and 9 that there is no evidence that the claimed limitation of *"at least one element for increasing grain size including Calcium (Ca) or Chromium (Cr)"* is inherent in prior art's device, because Edelstein et al. do not describe grain size.

Appellant further argues on page 8 that “the examiner is using improper “hindsight” by using appellant’s teachings for the rejection”.

As explained above, the claimed limitation of a *“copper alloy material including Zinc (Zn) or Silver (Ag) and at least one element for increasing grain size including Calcium (Ca) or Chromium (Cr)”* simply means that the inclusion of Calcium (Ca) or Chromium (Cr) in a copper alloy material comprising Zinc (Zn) or Silver (Ag) will increase the grain size. Edelstein et al. teach a copper alloy material including Zinc (Zn) or Silver (Ag) and at least one element including Calcium (Ca) or Chromium (Cr). Therefore, Edelstein et al.’s structure inherently includes the claimed limitation of *“at least one element for increasing grain size”,* as claimed.

Regarding appellant's argument that “the examiner is using improper “hindsight” by using appellant’s teachings for the rejection”, the examiner does not use appellant’s teachings for the rejection. The examiner merely states that the rejected claim recites the <u>physical phenomenon</u> that the inclusion of Calcium (Ca) or Chromium (Cr) in a copper alloy material comprising Zinc (Zn) or Silver (Ag) increases the grain size.

3. Appellant argues on pages 9 and 10 that Bogel et al. fail as “supporting evidence”, because *“Bogel et al. is in a completely different technology, because it is directed to under the hood automotive applications”.* Appellant further argues that Bogel et al. do not state that the inclusion of Calcium (Ca) or Chromium (Cr) increases the grain size,

because Bogel et al. merely state that *"FIG. 3 graphically illustrates the effect of solution annealing (SA) time and temperature on the recrystallization and grain growth for a copper alloy having 0.40% chromium", i.e. the "change in grain growth [is] due to annealing time and temperature, not by the addition of an element".*

Although Bogel et al. state that the alloy of the invention is suited for "under the hood automotive applications", Bogel et al. also states that the alloy of the invention is useful for computers (column 4, lines 63-65). It is well known in the art that computer structures comprise integrated circuits. Therefore, an artisan will be motivated to use the alloy of Bogel et al.'s invention in the claimed integrated circuit.

Regarding appellant's argument that Bogel et al. state that the change in grain growth is due to annealing time and temperature and not by the addition of an element, it is known and understood that although annealing change the grain growth, the inclusion of Calcium (Ca) or Chromium (Cr) also increase the grain size.

4. Appellant argues on pages 11-13 that *"Bogel et al. specifically states that its invention is directed to under the hood automotive applications"* and *"There is no suggestion that such a reference would be combined with Edelstein et al. which relates to the formation of interconnection structures in integrated circuits"* (page 11, second paragraph).

As explained above, although Bogel et al. state that the alloy of the invention is suited for "under the hood automotive applications", Bogel et al. also states that the alloy of the invention is useful for computers (column 4, lines 63-65). It is well known in the art that computer structures comprise integrated circuits. Therefore, an artisan will

be motivated to combine the alloy of Bogel et al.'s invention with the Edelstein et al. reference which relates to the formation of interconnection structures in integrated circuits".

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

O. N.

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